STOCHASTIC TEST ON THE MODEL FOR DENTAL DISEASES

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Abstract

We reported the model for dental diseases at the 1987 and 1992 International System Dynamics Conference.

The model contained 5 sectors; demography, cavities, pyorrhea, baby teeth, and technology. The demographic sector covered populations of 5 three-year age groups under 14 years of age and 13 five-year age groups above 15 years of age. The cavities sector and pyorrhea sector were composed of populations of five-year age groups, on the other hand, the baby teeth sector used populations of three-year age groups. By the technology sector we treated innovation effect on the model.

From the total number of defective teeth, total dental costs in Japan were calculated annually from 1963 and projected to 2025.

We added to this model random number variables, mainly in the demographic sector and we are testing stochastic changes on behaviors of various variables of the model.

Simulation runs with random birth rate changes show how their results are changed from the basic run.

1. MODEL FOR DENTAL DISEASES

1.1 Parts composing the model

This model consists of 5 sectors: demography, dental caries, pyorrhea, baby teeth, and technology. In each sector we deal with all of Japan. Relations among sectors are shown in Fig.1.

1.2 Demographic Sector

The demographic sector covers populations of 5 three-year age classes under 14 years of age and 13 five-year age classes above 15 years of age. The former are the classes 0-2, 3-5, 6-8, 9-11 and 12-14 years of age, and the latter are the classes of 15-19, 20-24, , 70-74 and 75- years of age. The population of each age class depends on the rates of birth and death. The first age class Z0 begins with births and ends where a new age class begins or, through deaths within the age class. Our other age classes Z3, Z6, , Z75 follow this same pattern.

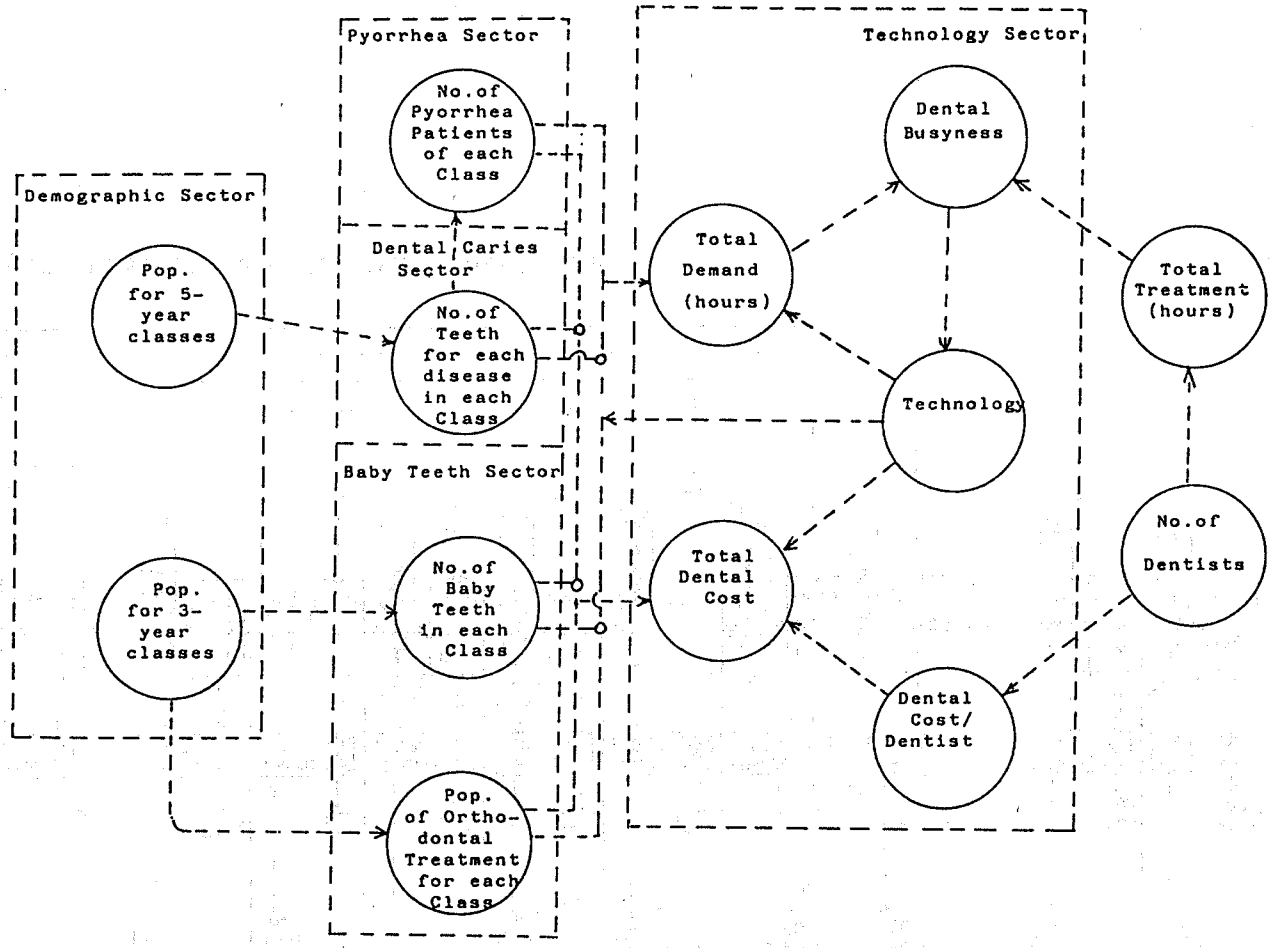

Fig.1 Relation among Sectors

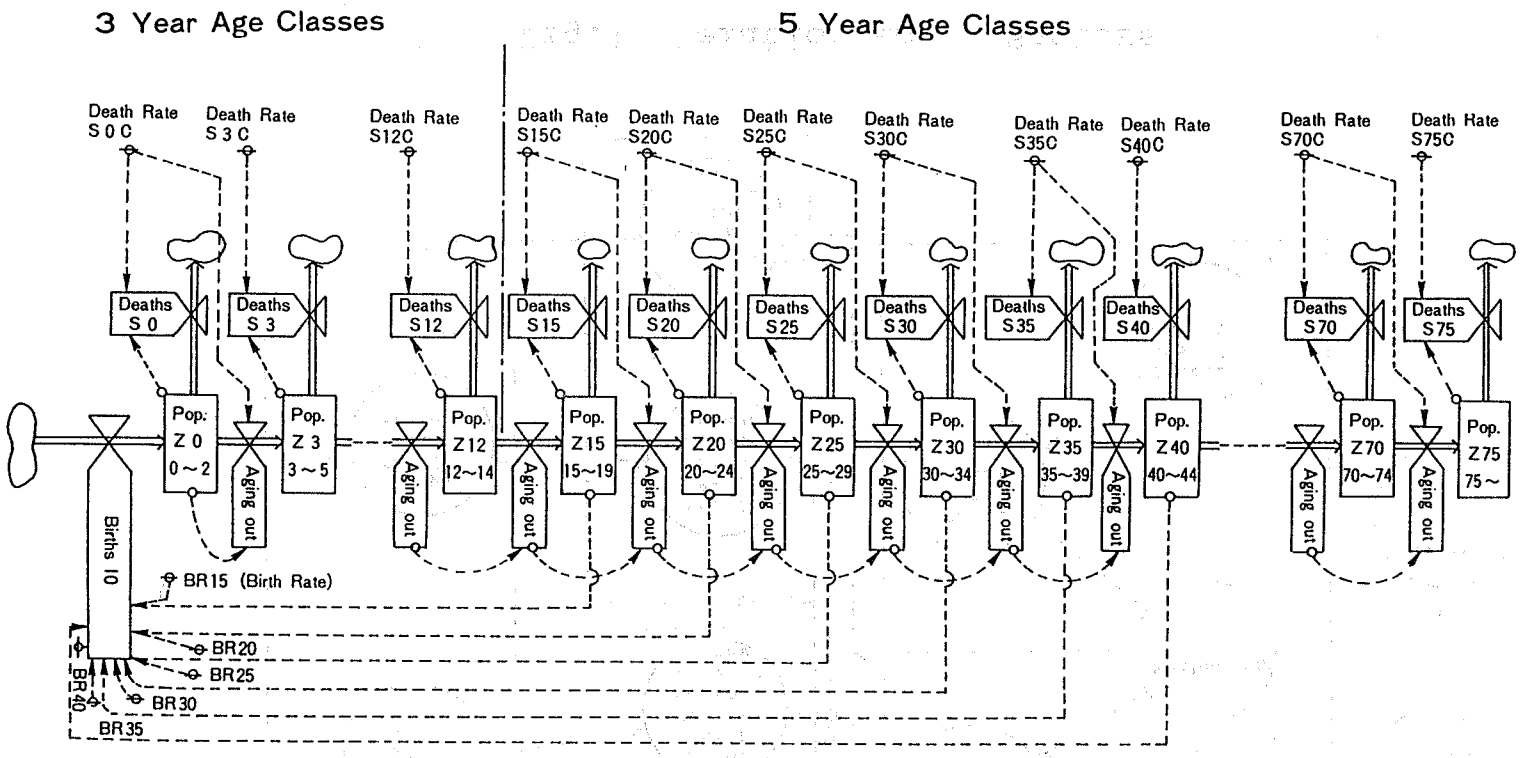

Fig.2 Flow Diagram for Demographic Sector

1. 3 Dental Caries Sector

The Dental Caries Sector has 13 subsectors corresponding to 13 five-year classes of the population sector.

Dental caries are classified as follows:

Healthy teeth : Carious symptoms and dental care are not recognized.

C0 : Similar to healthy teeth, but there is no agreement as to whether teeth are decayed or not.

C1 : Small surface cavities which may be easily filled and treated.

C2 : Cavities are worse than in C1, but health teeth may be restored by fillings being done without pulpectomy.

C3 : Cavities are worse than in C2, after pulpectomy. In some cases decayed teeth are only filled, but generally metal crowns may be used. In the case of front teeth complete care of bridges may be necessary.

C4 : Carious symptoms are serious enough that decayed teeth must be extracted and a denture may be necessary.

The number of C1 teeth is first computed. Then C2,C3,C4, filled teeth, crowns and bridges, missing teeth and dentures are successively computed as seen in Fig.3.

Data for this sector have all been collected by the Japan Dental Association.

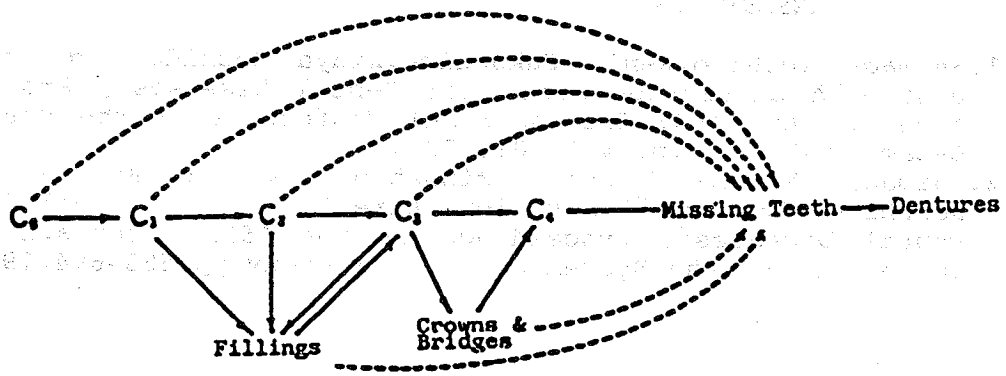

Fig.3 Relation among Diseases

2. THE EFFECT OF THE RANDOM NUMBER FUNCTIONS ON VARIABLES OF DEMOGRAPHIC SECTOR

Random birth rate changes were added to the basic model.

The mean was set equal to 0 and the standard deviation for each class was derived from the historical data by the least square method.

Fig.4 and Fig.5 show populations for the basic run and the run for random birth rates.

Fig.6 and Fig.7 show birth rates of the basic run and the run for random birth rates. Of course, the latter fluctuates severely.

Populations seen in Fig.5 are different from those in Fig.4. However, the long term trend seems not to be so much influenced, in spite of the remarkable changes of birth rates.

Random changes used in these runs are a sequence of random numbers generated in DYNAMO, and by other sequences with the same mean and the same standard deviation we obtained other runs, which are, of course, different from each other, but populations for each run show not so much difference.

3. CONCLUSION

We have attempted to formulate a System Dynamics model for dental diseases which have five sectors of demography, dental caries, pyorrhea, baby teeth and technology.

We added to this model random birth rate changes.The simulation results show that the long term trend seems not to be so much influenced, in spite of the remarkable changes of birth rates.

REFERENCES

1. Shimada Toshiro,Kenji Fukushima,Kinya Machida and Akira Uchino,"A Simulation Model for Dental Diseases", Proceedings of the 1987 International Conference of the System Dynamics Society,pp.476-481,1987.
2. Shimada Toshiro,Hirokazu Mizushima,Takahiro Kojima and Koichiro Okumura,"Innovation Effect on the Model for Dental Diseases", Proceedings of the 1992 International Conference of the System Dynamics Society,pp.685-694,1992.

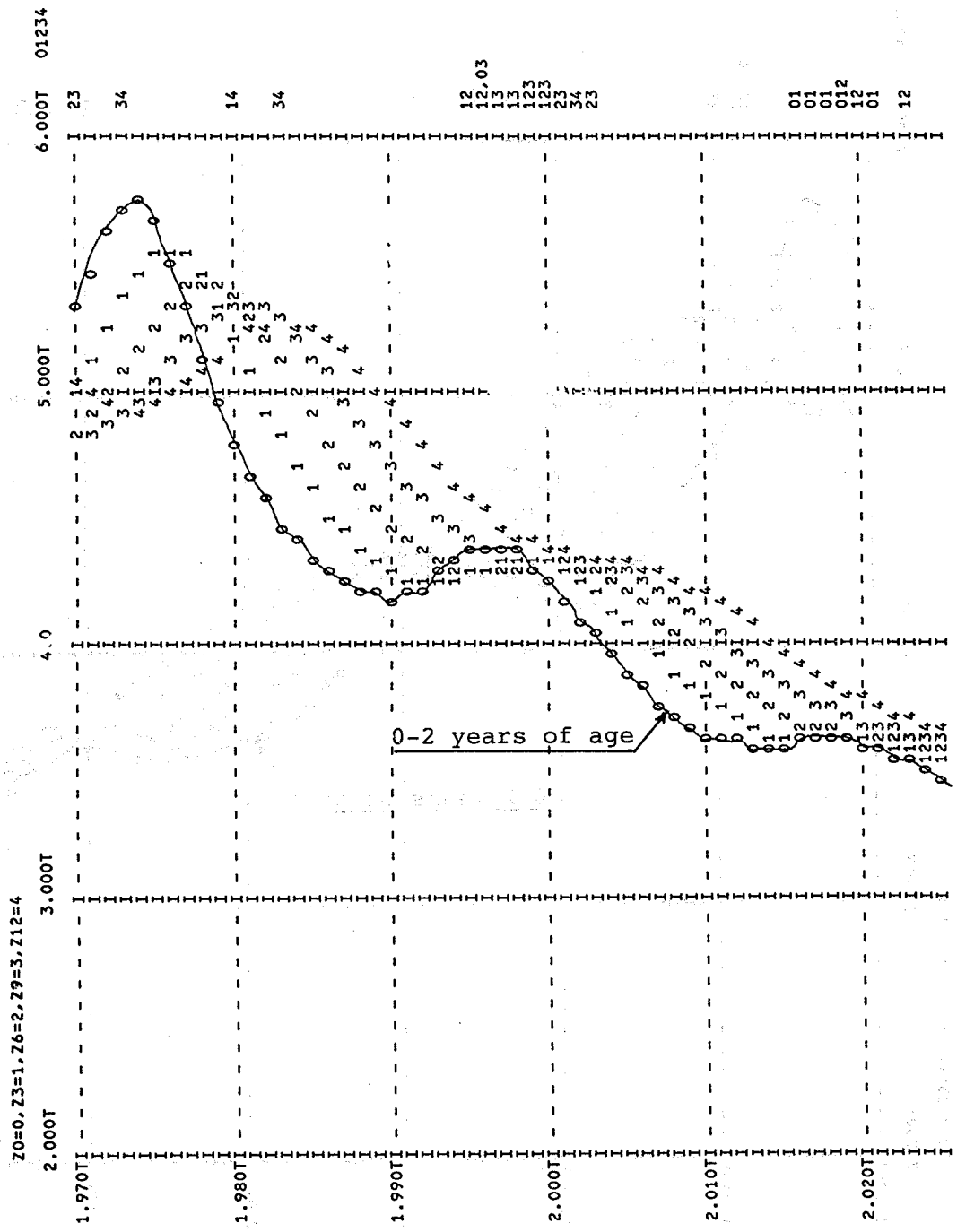

Fig.4 Populations of three-year age classes
(Basic run)

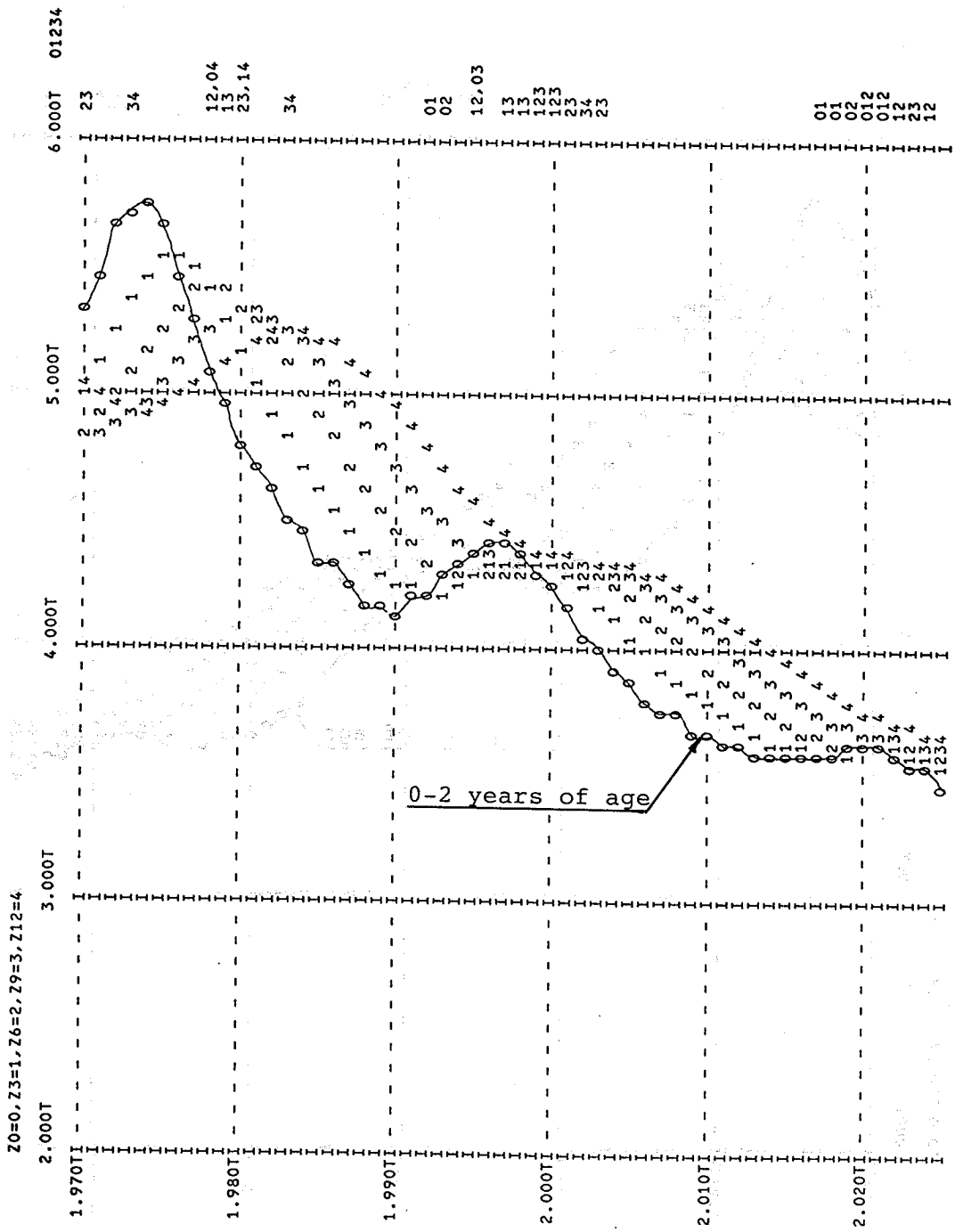

Fig.5 Populations of three-year age classes
(Run with random birth rate changes)

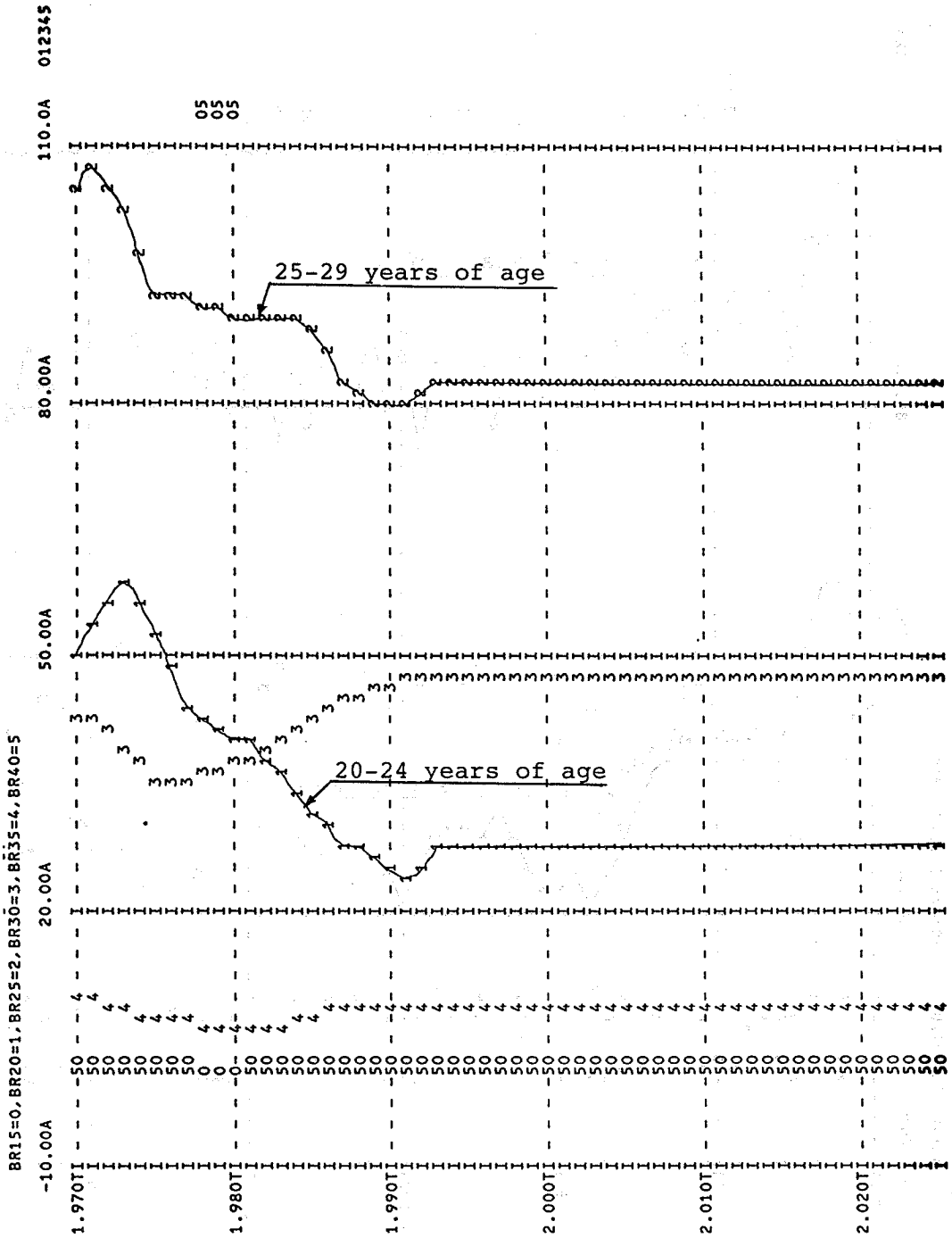

Fig.6 Birth rates of three-year age classes
(Basic run)

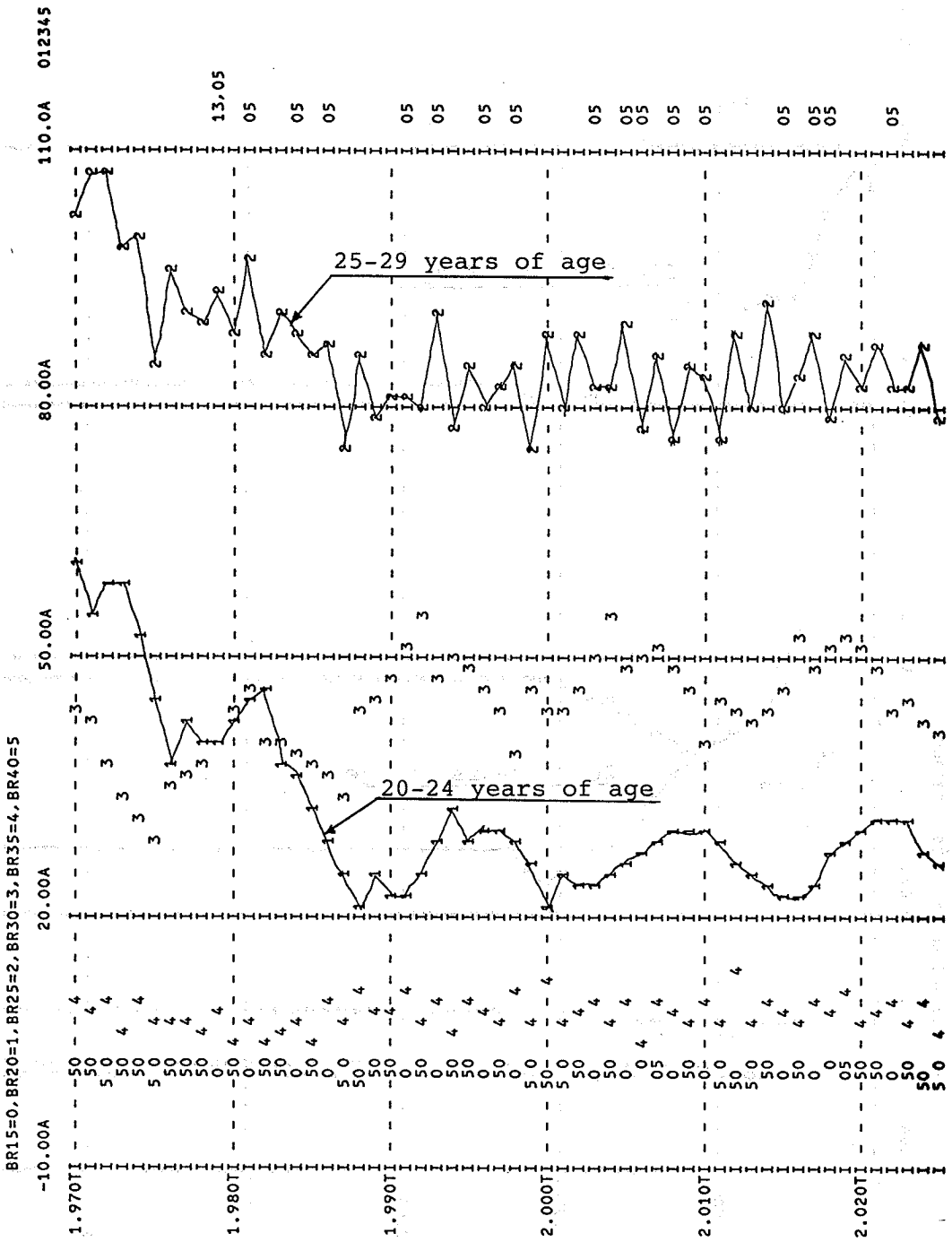

Fig.7 Birth rates of three-year age classes
(Run with random birth rate changes)